भारतीय मानक
Indian Standard

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बिटुमेन एडिशन के लिए एंटी-स्ट्रिपिंग पदार्थ — विशिष्टि

(दूसरा पुनरीक्षण)

Anti-Stripping Agents for Bitumen Addition — Specification

(Second Revision)

ICS 75.140 ; 93.080.20

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Bitumen, Tar and Related Products Sectional Committee, PCD 06

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards after the draft finalized by the Bitumen, Tar and Related Products Sectional Committee, had been approved by the Petroleum, Coal and Related Product Division Council.

The adhesion between bitumen and aggregate is an important factor for the stability and sustainable performance of bituminous pavements. It has been observed that very often the cause of distress and deterioration in a bituminous pavement is due to the water and moisture ingress into the pavement leading to the adhesion failure (stripping) of bitumen film from the aggregates Water has the ability to strip bitumen film from the aggregate surface and this is accelerated under traffic loading and constant climatic variations (wet and dry, freeze and thaw cycles).

As it is known that most of the aggregates being siliceous in nature are easily wetted by water and are water loving (hydrophilic affinity) by nature. This accelerates the issue of stripping. Worldwide it is a common practice to use anti-stripping agents to resolve the issue of stripping in bituminous mixes. Anti-stripping agents significantly improve the bond between bitumen and aggregate. Use of anti-stripping agents will ensure that moisture/water does not interfere at the interface of aggregate and bitumen and the bituminous mixes do not see stripping and disintegration arising due to water ingress.

The earlier standard was specific to one category of product (amines). However, with several technologies emerging globally, this revised standard accommodates all classes of anti-stripping additives that are being used in the industry from amines to phosphoric based to the new generation silanes.

Since publication of this standard in 2001, many new technologies have emerged globally. The earlier standard was product specific to one category of product (amines). The Standard was first revised in 2017. In the first revision all classes of additives were accommodated and emphasis was on performance. The tensile strength ratio was added to the standard as it will help to assess the loss of strength under wet condition. Minimum wet strength has been defined in order to ensure the additives do not affect the absolute value of wet strength required for pavement performance. Looking at the high temperature and the medium to heavy rainy monsoon season of 3-4 months in our climate zone, the Boil test has been extended from 10 min to 30 min to replicate actual field conditions and to ensure retention of bituminous coating to reduce stripping and ravelling and to eliminate development of potholes.

In this second revision, the requirement of solubility in high diesel oil in the ratio of 2 : 98 at ambient temperature has been deleted as it was felt that the requirement was no longer relevant and it is also not mentioned in any other standard on the subject worldwide. . Also the specified requirement of Wet strength has been corrected as a minimum of 7.50 KN. The requirement “Stripping value with bitumen containing 1.0 percent of anti-stripping agent” has been renamed as “Retained coating with bitumen containing 1.0 percent of anti-stripping agent” as the required value of 95 percent represents the retained coating and not the amount of coating that has undergone stripping.

In the formulation of this standard assistance has been derived from following standards:

AASHTO T 283 ‘Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage’

ASTM D 3625 ‘Standard Practice for Effect of Water on Bituminous-Coated Aggregate Using Boiling Water’

The Composition of the Committee responsible for formulation of this standard is given at Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ANTI-STRIPPING AGENTS FOR BITUMEN ADDITION — SPECIFICATION

(Second Revision)

1 SCOPE

1.1 This standard prescribes the requirements of anti-strip additives for reducing moisture susceptibility in bituminous mixes and materials. Hydrated lime and cement which are added directly to the aggregates are not in the scope of this standard.

1.2 This standard also provides guidance with respect to applications, storage, handling and safety precautions, and dosage of anti-stripping agents for use in bituminous materials and mixes.

2 REFERENCES

The following standards contain provisions which, through reference in the text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

IS No.	*Title*
334 : 2002	Glossary of terms relating to bitumen and tar (*third revision*)
1202 : 2021	Methods of testing tar and bituminous materials — Determination of specific gravity (*first revision*) (*under print*)
1209 : 2021	Methods for testing tar and bituminous materials — Determination of flash point and fire point (*first revision*) (*under print*)
1211 : 2021	Methods for testing tar and bituminous materials — Determination of water content (*first revision)*
1448 [P : 10/Sec 2] : 2013/ISO 3016 : 1994	Methods of test for petroleum and its products: Part 10 Cloud point and pour point, Section 2 Determination of pour point

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 334 and the following shall apply.

3.1 Stripping — Stripping is the breaking of the adhesion bond between the aggregates and the bituminous binder. In one way or the other water gets in between the binder film and the aggregate surface and because the aggregate surface has higher attraction for water than for bituminous binder the adhesive bond is broken.

3.2 Active Adhesive — If an anti-stripping agent is added to the bituminous binder, even wet aggregate surface may be coated. This is defined as active adhesive.

3.3 Passive Adhesive — The process of forming and maintaining a strong adhesive bond between binder and dry aggregate surface is defined as passive adhesive.

In such case the passive adhesive is the ability of the bitumen to maintain the integrity of the adhesive bond with aggregate to prevent stripping under wet condition once bond formation is achieved.

4 MATERIALS

Any chemical additive suitable for modification of bituminous binder, which is effective to prevent the stripping of any aggregate, may be used. When optimized dosage of the additive is added to the bitumen binder it shall not change the original viscosity grading of the binder, in case of modified binder it shall not adversely affect the specification parameters.

5 REQUIREMENTS

5.1 Anti- stripping agent either liquid or powder shall be homogeneous materials having tolerable odour.

5.2 The physical and performance requirements of the anti-stripping agents shall comply with the requirements specified in Table 1.

6 SAMPLING

6.1 For the purpose of testing, the sampling procedure from drums, barrels or tank shall be as follows:

The content of drum or barrel from which the sample is to be drawn shall be warmed up to 45-55 °C, if required, and thoroughly mixed by rolling to and fro on the ground for a period of 5 to 10 min. Where practicable, the content of that tank shall be agitated by forced circulation of air before sampling.

6.1.1 *Preparation of Samples*

Before carrying out any of the tests, the sample shall be mixed by gentle shaking to ensure uniformity.

6.2 If the single sample from a single run fails to fulfill the test requirements specified under **5**, sample shall be drawn on the basis of **6.1** for testing in the same manner. If these samples conform to requirement of **5**, the lot shall be accepted otherwise the lot shall be rejected.

7 TESTS

Unless otherwise specified, tests shall be carried out according to the methods referred to in Table 1.

8 MARKING

8.1 Each container shall be legibly and indelibly marked with the following:

a) Name of the product;
b) Indication of the source of manufacture;
c) Month and year of manufacture;
d) Batch number or code number; and
e) Expiry date.

8.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

9 APPLICATIONS

9.1 Anti-stripping agents can be used for the following two applications:

a) *For bituminous Surfacing (Sprayed work)* — It covers road construction like surface dressing, penetration macadam, built up spray grout, etc.
b) *For Bituminous Surfacing (Premixed Surfacing)* — It covers bituminous surfacing like open graded premix carpet mix seal surfacing, bituminous macadam, dense bituminous macadam semi dense asphaltic concrete and dense asphaltic concrete. Stone matrix asphalt, porous asphalt.

Table 1 Requirements for Anti-Stripping Agents

(*Clauses* 5.2 *and* 7)

Sl No.	Characteristic	Requirement	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Specific gravity at 27 °C	0.85-1.10	IS 1202
ii)	Pour point °C, *Max*	42	IS 1448 [P : 10/Sec 2]
iii)	Flash point, °C (COC), *Min*	75	IS 1209
iv)	Water content, percent by volume, *Max*	1.0	IS 1211
v)	Thermal stability at 163 °C, 24 h	No appreciable change in efficacy	Annex A
vi)	Under water coating test with maximum 1 percent anti-stripping agent (Active adhesion) for spray work	Complete coating	Annex B
vii)	Retained Coating with bitumen containing maximum 1.0 percent of anti-stripping agent (boiling water test for 30 min), *Min*	95 percent	Annex C
viii)	Indirect tensile strength ratio, *Min*	80 percent	Annex D
ix)	Wet Strength , *Min*	7.50 KN	Annex D

NOTE — The sample of anti-stripping agent shall be drawn within 24 h after delivery and tested within 7 days from the date of drawing, unless otherwise specified.

9.2 Application of Anti-Stripping Agents for Bituminous Surfacing (Sprayed Work)

For this purpose the anti-stripping agent must be well mixed with the binder. The type of anti-stripping agent supplied is either liquid or solid. It will be fed into the bulk distributor through the manhole preferably fitted with a stirring device. The binder with agent shall be circulated by means of spray pump for at least 30 min to ensure homogeneous mixing. The additive can also be kept heated in a special storage tank attached to the bitumen tank. It shall be fed by a small dosage pump into the pipe supplying the bitumen throughout the operation. This ensures that the agent is mixed in the tank and also saves time.

9.3 Application of Anti-stripping Agents for Bituminous Surfacing (Premixed Surfacing)

In asphalt plant, the aggregate is normally dried and heated then mixed with bitumen. The mixing temperature varies between 120° and 175 °C for warm/hot mixes, depending mainly on the grade of bituminous binder. With moist and partially wet aggregate the desired adhesion can be achieved by addition of anti-stripping agent. The amount of anti-stripping agent to be added depends upon the type and viscosity of the bitumen and type and gradation of aggregate.

Anti-stripping agents dissolve easily in bitumen products, If the bitumen temperature is 130 °C-175 °C. There are two methods for adding an agent. The most commonly used is to pour the calculated amount into the bitumen tank and allow 15-30 min of circulation to ensure a homogeneous mix and in this case it is necessary to use heat stable anti-stripping agent which can be stored in hot bituminous binder for 24 h without any significant loss in efficiency. The second method is to co-inject using metering pump when bitumen is pumped.

In the drum mix process, the aggregate is mixed with bitumen in the drum. Very often the aggregate contains a certain amount of moisture content and normally remains in the aggregate after mixing. The required adhesion in the process can be ensured by use of an anti-stripping agent.

10 STORAGE OF ANTI-STRIPPINGAGENTS

10.1 Anti-stripping agents are stable at normal temperature for many years provided they are stored in closed drums, barrels or tanks.

10.2 The anti-stripping agents are freeze thaw stable, but prolonged storage at low temperature may cause liquid anti-stripping agents to freeze. These should be allowed to thaw and melt on heating.

10.3 Solid anti-stripping agents should be stored at temperature below their melting point (40-50 °C).

10.4 Steel, aluminium containers or plastic such as drums, tanks, etc, are suitable for storage of anti- stripping agents as specified in material safety data sheet. Gaskets and hoses, made from teflon or polyamide should be used.

11 HANDLING AND SAFETY PRECAUTIONS

11.1 The anti-stripping agents with HMIS rating 0-3 only can be used with proper safety guidelines.

11.2 When handling anti-stripping agents, always use PPEs as per MSDS guidelines provided by anti-stripping agent supplier. They should be kept away from public, especially from children.

11.3 In case of contact with eyes flush with water for at least 15 min and follow MSDS.

11.4 In case of fire, follow MSDS guidelines.

11.5 If spillage has occurred, then also MSDS guidelines will be followed to remove contamination.

12 ADDITIVE DOSAGES

12.1 The dose of anti-stripping agent depends upon the nature of aggregates, that is, silicate content and the porosity. Higher quantity of dose is required for open surfaces like surface dressing bituminous macadam, open graded premix carpet and mix seal surfacing. In the case of dense bituminous mixes or semi-dense bituminous binder a lesser quantity of anti-stripping agent is required. Follow the guidelines of manufacturer to determine optimum dosage which allows meeting the requirement as specified in Table 1.

12.2 The actual dose of anti-stripping agent shall also depend on the quality of anti- stripping agent. The method for determination of dose concentration is detailed in Annex B for spray work and Annex C and Annex D for pre-mix work.

ANNEX A

[*Table* 1, *Sl No*. (v)]

TEST FOR THERMAL STABILITY OF ANTI-STRIPPING AGENT

A-1 OUTLINE OF THE METHOD

This test determines whether any degradation in quality of anti-stripping agent is caused as a result of its storage in hot bitumen at 163 °C for 24 h.

NOTE — Test for spray work.

A-2 REAGENTS

Use cut-back bitumen MC-3000 (4 parts of bitumen and one part of kerosene) for spray work and only bitumen for premix.

A-3 PROCEDURE

For premix work blends of optimized dosage of anti-strip agent and bitumen will be prepared and kept in an oven at 163 °C for 24 h in the sealed condition. After heat exposure, the blended samples can be used for premix sample preparation to meet the specification of Table 1 [Sl No. (vii), viii) and (ix)]. For spray it is fluxed with kerosene oil to obtain cut-back bitumen of consistency of MC-3000 and tested for under water coating as per Annex B and used as such for HMA mixes test described in Annex C and Annex D.

A-4 REPORTING OF TEST RESULTS

Anti-stripping agent is deemed to be heat resistant, if the dose requirement before and after heat exposure can meet the requirement laid down as per Table 1.

ANNEX B

[*Clauses* 12.2, A-3 *and Table* 1, *Sl No*. (vi)]

UNDER WATER COATING TEST (FOR SPRAYED WORK)

B-1 GENERAL

This test is meant for dose determination of anti-stripping agent for sprayed work.

B-2 PROCEDURE

Anti-stripping agent (0.02 to 1.0 percent) shall be blended with cut-back bitumen MC-3000 (4 parts of bitumen and 1part of kerosene oil). These blends shall be used for testing their efficacy to coat the road aggregates under water.

In a tin container of 1litre capacity, about 200 g of coarse aggregate of 13.2 mm nominal size (passing 22.4 mm sieve and retained in 11.2 mm sieve) shall be taken. The container shall be filled to 3/4th of its capacity with distilled water at 40 °C. The bitumen anti-stripping agent blend shall be added at rate of 5.0 percent by weight of aggregate. The lid shall be replaced and container shall be vigorously shaken for 2 min. The water shall be drained off and aggregate piece shall be transferred on to a pieces of white paper and examined visually for coating. The test shall be repeated for different percentages of anti-stripping agent.

B-3 REPORT

The percent content of anti-stripping agent capable of giving 100 percent coating of coarse aggregate shall be taken as optimum dose for sprayed work.

ANNEX C

[*Clause* 12.2 *and Table* 1, *S1 No*. (vii)]

COATING RETENTION TEST (FOR PREMIX WORK)

C-1 GENERAL

This test is meant for dose determination of anti-stripping agent for premix work.

C-2 PROCEDURE

The anti-stripping agent shall be blended in percent content should be 0.02, 0.05, 0.1, 0.2, 0.4, 0,6, 0.8 and 1 percent in bitumen. These blends shall be used for testing their efficacy in retaining bitumen film on coated aggregates.

200 g of coarse aggregates of 13.2 mm nominal size (passing 22.4 mm sieve and retained on 11.2 mm sieve) shall be heated to 150 °C and mixed with 8g of bitumen and anti-stripping agent blend at 150 °C in a casserole with a spatula. Time of coating should be noted and reported. The material should be heated till mixing is complete to maintain 150°C mixing temperature.

After complete coating the mixture shall be transferred to a tray and allowed to condition at 135 °C for 2 h and then transferred to 500 ml beaker and allowed to cool at the room temperature for about 2h. Distilled water shall then be added to submerge the coated aggregates upto 500 ml mark of beaker.

Put the beaker on hot plate and start heating, bring the water temperature to boiling and note the time, continue boiling for 30 more minutes, at 10, 20, 30 min remove the floating bitumen from the top by spatula to avoid redeposition.

C-3 VISUAL INSPECTION

The aggregate will be taken out and allow to dry at room temperature. The brownish surface as well as completely stripped surface will be considered as stripped area. Only glossy black or dull black portion of the aggregate shall be considered as coated surface.

C-4 REPORT

The percentage of anti-stripping agent which retains 95 per cent coating of the aggregate shall be taken as minimum dose for premix work.

ANNEX D

[*Table* 1, *Sl No* (viii *and* ix)]

DETERMINATION OF RETAINED INDIRECT TENSILE STRENGTH (FOR PREMIX WORK)

D-1 OUTLINE OF THE METHOD

A numerical index of reduced Indirect Tensile Strength (ITS) is obtained by comparing indirect tensile strength of the freshly moulded and cured samples with the indirect tensile strength of triplicate samples at 30 blows from both sides that have been immersed in water for 24 h at 60 °C.

D-2 APPARATUS

D-2.1 Water-Baths

D-2.1.1 Automatically controlled water-bath for bringing the immersed test samples to 60 ± 1 °C for indirect tensile strength test.

D-2.1.2 *Water-Bath for Density Measurement* — An ordinary water-bath for weighing the test samples in water in order to determine their densities.

D-2.2 Balance — Suitable for weighing the test samples in air and water.

D-2.3 Transfer Plates — Sufficient number of flat steel plates of sufficient size to keep the test samples.

NOTE — The water used for the wet storage of test samples shall be either distilled or otherwise treated to eliminate electrolytes with conductivity less than 10 micro Siemens/cm.

D-3 PROCEDURE

For quantitative evaluation, the test shall be carried out on Marshall specimen. The Marshall test specimens shall be prepared using mix design with optimum binder content with specified percent anti-stripping agents. The temperature of the mixing should not exceed 175 °C. Mixes should be prepared with maximum 120 coating time and further conditioned at 135 °C for 2 h. Six specimens should be prepared with 30 blows on each side at 135 °C. Each set of 6 test specimens shall be sorted out in two groups of 3 each so that the average specific gravity of the specimens in Group I shall be almost the same as in Group II. Group I specimen shall be tested for indirect tensile strength. Keep the samples at room temperature and then place in a 25 °C water bath for 2 h prior to determining their indirect tensile strength. Group II specimens shall be immersed in water at 60 °C for 24 h. and then conditioned in water at 25 °C for 2 h and then tested for tensile Strength. Retained indirect tensile strength will be calculated as under:

Retained indirect tensile strength, percent

$$= \frac{\text{Average tensile strength of Group II}}{\text{Average tensile strength of Group I}} \times 100$$

Average tensile strength of Group II will be wet average tensile strength.

D-4 REPORT

The retained indirect tensile strength will be reported.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Bitumen,Tar and Related Products Sectional Committee, PCD 06

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